OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **GOULD POND, HILLSBORO** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the lake/pond this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

As part of the state's lake survey program, DES biologists performed a comprehensive lake survey on **GOULD POND** this summer. Publicly-owned recreational lakes/ponds in the state are surveyed approximately every ten to fifteen years. In addition to the tests normally carried out by VLAP, biologists tested for certain indicator metals and nitrogen, created a map of the lake/pond bottom contours (referred to as a bathymetric map), and mapped the abundance and distribution of the aquatic plants along the shoreline. DES biologists will also sample the lake/pond once during the Winter of 2004-2005. Some data from this lake survey have been included in this report and has been added to the historical database for your lake/pond. If you would like a complete copy of the raw data from the lake survey, please contact the DES Limnology Center at (603) 271-3414 or (603) 271- 2658. A final report should be available in 2006 and a copy will be available at any state library.

We would like to encourage your monitoring group to formally participate in the DES Weed Watchers program, a volunteer program dedicated to monitoring the lakes and ponds for the presence of exotic aquatic plants. This program only involves a small amount of time during the summer months. Volunteers survey their waterbody once a month from **June** through September. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the waterbody and any islands it may contain. Using the materials provided in the Weed Watchers Kit, volunteers look for any species that are of suspicion. After a trip or two around the waterbody, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers will send a specimen to DES for identification. If the plant specimen is an exotic, a biologist will visit the site to determine the extent of the problem and to formulate a plan of action to control the nuisance infestation. Remember that early detection is the key to controlling the spread of exotic plants.

If you would like to help protect your lake or pond from exotic plants, contact Amy Smagula, Exotic Species Program Coordinator, at 271-2248 or visit the Weed Watchers web page at www.des.state.nh.us/wmb/exoticspecies/survey.htm.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 mg/m^3.**

  The current year data (the top graph) show that the chlorophyll-a concentration ***remained stable*** from **June** to **July**, and then ***increased*** from **July** to **August**. The chlorophyll-a concentration on the **June** and **July sampling** events was ***less than*** the state mean, and in **August** was approximately ***equal to*** the state mean.

  The historical data (the bottom graph) show that the 2004 chlorophyll-a mean is ***slightly less than*** the state mean.

  Overall, the statistical analysis of the historical data shows that the chlorophyll-a concentration has ***significantly decreased*** during the sampling period **1989 to 1999**. Specifically, the chlorophyll-a concentration has ***decreased*** (meaning ***improved***) on average ***by approximately 14%*** during this period. (Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

  Please note that the lake was not sampled in 2000, therefore, it was not possible to conduct a regression analysis of the data from 1989 to 2004. It is important to point out that the chlorophyll concentration was elevated in 2001 and 2002, but has returned to lower, more-characteristic levels during 2003 and 2004.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  The current year data (the top graph) show that the in-lake transparency ***increased*** from **June** to **July**, and then ***decreased slightly*** from **July** to **August**. The transparency in **June** and **August** was ***less than*** the state mean, and in **July** was ***approximately equal to*** the state mean.

  Overall, the statistical analysis of the historical data show that the mean annual in-lake transparency has ***significantly increased*** during the sampling period **1989 to 1999**. Specifically, the transparency has ***increased*** (meaning ***improved***) on average by ***approximately 4.7%*** per sampling season during this sampling period. (Again, please note that the lake was not sampled in 2000, therefore, it was not possible to conduct a regression analysis of the data for the sampling period 1989 to 2004.)

  The annual mean transparency during the sampling period **2001 through 2004** has remained ***stable*** at approximately **3.0 meters**.

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased*** from **June** to **July**, and then ***increased greatly*** from **July** to **August**. The phosphorus concentration in **June** was ***approximately equal* to the state median,** in **July** was ***less than*** the state median, and in **August** was **much greater than** the state median.

  The historical data shows that the 2004 mean epilimnetic phosphorus concentration is ***slightly greater than*** the state median.

  The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased steadily*** from **June** to **August**. The phosphorus concentration on **each sampling event** was ***greater than*** the state median.

  The turbidity of the hypolimnion (lower layer) sample was ***elevated*** on ***each*** sampling event (**5.0, 7.77, and 4.72 NTUs** respectively.) This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling or that the lake bottom has an easily disturbed layer of fine organic material. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column.

When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

Overall, the statistical analysis of the historical data shows that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion ***significantly decrease*d (meaning improved)** during the sampling period **1989-1999.** Specifically, on average, the epilimnetic phosphorus ***decreased*** by ***approximately 7.3 %*** per sampling season and the hypolimnetic phosphorus concentration ***decreased*** by approximately **9.9%**. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.) We hope this trend continues!

It is important to note that the mean annual epilimnetic phosphorus concentration has ***gradually increased (meaning worsened)*** during the sampling period **2001 through 2004**. During this period, the hypolimnetic phosphorus concentration has ***fluctuated*** and has been ***elevated.*** We hope that these trends do not continue.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 (Appendix B) lists the current and historical phytoplankton species observed in the lake/pond. Specifically, this table list the three most dominant phytoplankton species observed in the sample and their relative abundance in the sample. In addition, this table has been enhanced this year to include the overall phytoplankton cell abundance rating of the sample. The overall phytoplankton cell abundance in a sample is calculated using a formula based on the relationship that DES biologists have observed over the years regarding phytoplankton concentrations, algal concentrations, and biological productivity in New Hampshire's lakes and ponds. A mathematical equation is used to classify the overall abundance of phytoplankton cells in a sample into the following categories: *sparse, scattered, moderate, common, abundant,* and *very abundant.* Generally, the more phytoplankton cells there are in a sample, the higher the chlorophyll concentration and the higher the biological productivity of the lake.

The dominant phytoplankton species observed in the **June** sample were ***Tabellaria*** **(diatom),** ***Asterionella*** **(diatom),** ***and Anabaena*** **(cyanobacteria).**

The dominant phytoplankton species observed in the **July** sample were ***Chrysosphaerella*** **(golden-brown),** ***Mallomonas*** **(golden-brown),** ***and Dinobryon*** **(golden-brown).**

The calculated overall abundance of rating phytoplankton cells in the **June** was ***scattered*** and in **July** was ***moderate.***

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria**

In June, the cyanobacterium ***Anabaena*** was the ***third-most*** dominant species in the phytoplankton sample. In July, small amounts of the cyanobacterium ***Anabaena*** and ***Microcystis*** were observed in the phytoplankton sample.

These species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans. (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased (this is often caused by rain events) and favorable environmental conditions occur (such as a period of sunny, warm weather).

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please collect a sample (any clean jar or bottle will be suitable) and contact the VLAP Coordinator.

- **Table 4: pH**

  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the surface waters in the state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH at the deep spot this season ranged from **5.79** in the hypolimnion to **6.67** in the epilimnion, which means that the water is ***slightly acidic.***

  It is important to point out that the pH in the hypolimnion (lower layer) was ***lower (more acidic)*** than in the epilimnion (upper layer). This increase in acidity near the lake bottom is likely due the decomposition of organic matter and the release of acidic by-products into the water column.

  Due to the presence of granite bedrock in the state and acid deposition (from snowmelt, rainfall, and atmospheric particulates) in New Hampshire, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

  Table 5 (Appendix B) presents the current year and historical epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

  Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The mean ANC value for New Hampshire's lakes and ponds is **6.6 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **5.1 mg/L** this season, which is ***slightly less than*** the state mean. In addition, this indicates that the lake/pond is ***moderately vulnerable*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

Table 6 (Appendix B) presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current (which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column). The mean conductivity value for New Hampshire's lakes and ponds is **59.4 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual conductivity in the epilimnion at the deep spot this season was **40.18 uMhos/cm**, which is ***slightly less than*** to the state mean.

The conductivity has ***gradually increased*** in the lake/pond and inlets since monitoring began. Typically, sources of increased conductivity are due to human activity. These activities include septic systems, agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct stream surveys and storm event sampling along the inlet(s) with ***elevated*** conductivity (particularly, **Beaver Glen Brook** and the **Boat Access Brook**) so that we can determine potential sources to the lake.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

We also recommend that your monitoring group conduct a shoreline conductivity survey of the lake and the tributaries with ***elevated*** conductivity to help pinpoint the sources of ***elevated*** conductivity.

- **Table 8: Total Phosphorus**

  Table 8 (Appendix B) presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The total phosphorus concentration was ***elevated*** in the **Beaver Glen Brook** on **each of the three sampling events** this summer (**42, 77, and 126 ug/L**, respectively). The turbidity of these samples was ***slightly elevated*** (**3.52, 2.39, and 3.62 NTUs,** respectively). This station has had a history of ***fluctuating*** total phosphorus concentrations. We recommend that your monitoring group conduct a stream survey and storm event sampling along this inlet so that we can determine what may be causing the increase.

  For a detailed explanation on how to conduct rain event sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2004 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  During this season, and many past sampling seasons, the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (lower layer) than in the epilimnion (upper layer). These data suggest that the process of ***internal phosphorus loading*** is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it was on each of the three sampling events this season and in many past seasons)**, the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column. Since an internal source of phosphorus in the lake/pond may be present, it is even more important that watershed residents act proactively to minimize phosphorus loading from the watershed.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, the turbidity of the hypolimnion (lower layer) sample was ***elevated*** on each of the three sampling events. Historically, the turbidity has been ***elevated*** in the hypolimnion on most sampling events. This suggests that the lake bottom is composed of a thick layer of organic material. The presence of a thick organic layer on the lake bottom (which is likely comprised of decomposed plants and algae, and also sediment) would also explain the lower dissolved oxygen concentration near the lake bottom.

  As discussed previously, the turbidity in the **Beaver Glen Brook** samples continued to be ***elevated*** on each sampling event this season. This suggests that the stream bottom may have been disturbed while sampling, but more likely suggests that erosion is occurring in this portion of the watershed.

  If you suspect that erosion is occurring in this portion of the watershed, we recommend that your monitoring group conduct a stream survey and storm event sampling along this inlet. This additional sampling may allow us to determine what is causing the ***elevated*** levels of turbidity.

  For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

- **Table 12: Bacteria (*E.coli*)**
  Table 12 lists the current year and historical data for bacteria *(E.coli*) testing. (Please note that Table 12 now lists the maximum and minimum results for this season and for all past sampling seasons.) *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms **MAY** also be present.

  If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct

E. coli testing when the water table is high, when beach use is heavy, or immediately after rain events.

- **Table 13: Chloride**

  The chloride ion (Cl^-) is found naturally in some surfacewaters and groundwaters and in high concentrations in seawater. Research has shown that ***elevated*** chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted acute and chronic chloride criteria of 860 and 230 mg/L respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The **epilimnion** and **hypolimnion** were sampled for chloride on the **August** sampling event. The results were **4.0 mg/L and 5.0 mg/L**, respectively, which is ***much less than*** the state acute and chronic chloride criteria.

- **Table 14: Current Year Biological and Chemical Raw Data**

  This table is a new addition to the Annual Report. This table lists the most current sampling season results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw" (meaning unprocessed) data. The results are sorted by station, depth zone (epilimnion, metalimnion, and hypolimnion) and parameter.

- **Table 15: Station Table**

  This table is a new addition to the Annual Report. As of the Spring of 2004, all historical and current year VLAP data is included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past (and are most familiar with), an EMD station name also exists for each VLAP sampling location. For each station sampled at your lake or pond, Table 15 identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

<u>USEFUL RESOURCES</u>

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES Booklet WD-03-42, (603) 271-2975.

Canada Geese Facts and Management Options, NHDES Fact Sheet BB-53, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-53.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet WMB-10, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, NHDES Fact Sheet WD-SP-1, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-1.htm.

Impacts of Development Upon Stormwater Runoff, NHDES Fact Sheet WD-WQE-7, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-7.htm.

Lake Foam, NHDES Fact Sheet WD-BB-4, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-5.htm.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, NHDES Fact Sheet WD-BB-9, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, NHDES Fact Sheet WD-SP-2, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Sand Dumping - Beach Construction, NHDES Fact Sheet WD-BB-15, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-15.htm.